

S6 • Interpreting frequency graphs, cumulative frequency graphs, box and whisker plots

Mathematical goals

To help learners to:

- interpret frequency graphs, cumulative frequency graphs, and box and whisker plots, all for large samples;
- see how a large number of data points can result in the graph being approximated by a continuous distribution.

Starting points

It is recommended that, before doing this session, learners try the similar but easier session **S5 Interpreting bar charts, pie charts, box and whisker plots**.

Materials required

- Overhead projector;
- OHT 1 – *Discrete and continuous representations*;
- OHT 2 – *Cumulative frequency, box and whisker*;
- OHT 3 – *Frequency, cumulative frequency, box and whisker*.

For each small group of learners you will need:

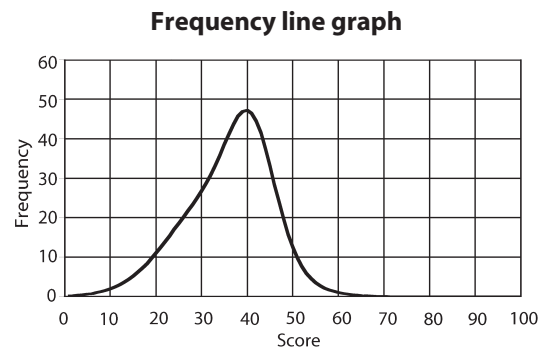
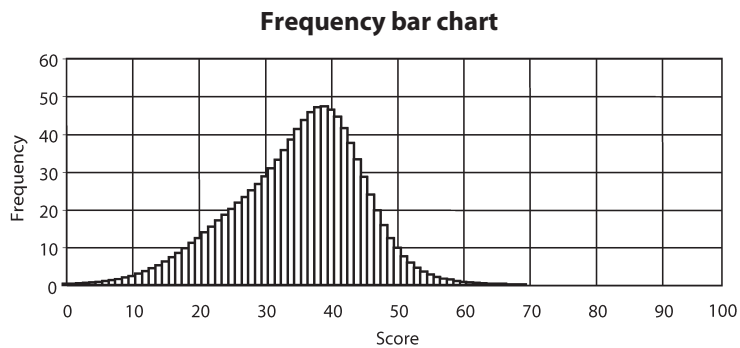
- Card set A – *Frequency graphs*;
- Card set B – *Statements*;
- Card set C – *Cumulative frequency graphs*;
- Card set D – *Box and whisker plots*;
- Sheet 1 – *Make up your own examples*;
- large sheet of paper for making a poster;
- felt tip pens;
- glue stick.

Time needed

About 1–2 hours.

Suggested approach Beginning the session

Display OHT 1 – *Discrete and continuous representations*. Explain to learners that the bar chart represents the scores of candidates in an examination where the maximum mark was 100.



When we have a distribution like this, where there are many bars close together, we can represent the graph as a continuous line, as in the frequency graph. This makes it a little easier to read off values.

What can you say about the exam? Did the candidates find it hard or easy? How can you tell?

What was the range of scores?

What was the modal score?

Do you think the mean score was the same as the mode, or was it higher or lower? How can you tell?

Roughly how many candidates sat the exam?

Could we begin to draw the frequency table for this data? It would take a long time, wouldn't it?

Explain that the grouped frequency table shows the same data in summary form. It is quite hard to see this, as the values are the sums of the heights of all the small bars.

Display OHT 2 – *Cumulative frequency, box and whisker*.

| | | | | | | | |
|-----------|------|-------|-------|-------|-------|-------|-------|
| Score | 0–10 | 11–20 | 21–30 | 31–40 | 41–50 | 51–60 | 61–70 |
| Frequency | 10 | 60 | 230 | 420 | 250 | 28 | 2 |

| | | | | | | | |
|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Score | ≤ 10 | ≤ 20 | ≤ 30 | ≤ 40 | ≤ 50 | ≤ 60 | ≤ 70 |
| Cumulative frequency | 10 | 70 | 300 | 720 | 970 | 998 | 1 000 |

Explain that the cumulative frequency row displays a running total of the data. Ask the group to help you complete it.

Can you now see how many candidates sat the exam?
 How many scored less than or equal to 50 marks?
 How many scored more than half marks?

Explain that examiners often need to work out the median value and the quartiles of the distribution, so that they can compare the standard of the exam from one year to the next. After all, one would expect the 'average' student from one year to do about as well as the 'average' student the next year. This is easily done using a cumulative frequency diagram.

Plot the cumulative distribution with the group. This does not need to be done in detail.

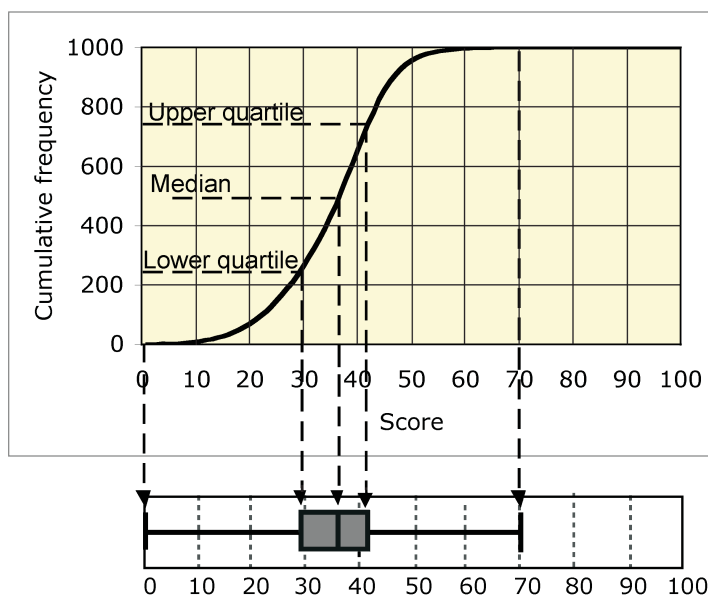
The median score will be that obtained by the 500th candidate.

How can we find the median from this graph?

The lower quartile will be the score obtained by the 250th candidate.

How can we estimate this from the graph?

In this way, develop the box and whisker plot from the graph:



Now, introduce the task for the session, using OHT 3 – *Frequency, cumulative frequency, box and whisker*.

In this session, your job is to try to match the frequency graph, cumulative frequency graph, and box and whisker plot.

Working in groups

Give each pair of learners Card sets A, B, C and D. They should take it in turns to match the frequency graphs, the statements, the cumulative frequency graphs and the box plots. When they are

certain they have a correct combination, they should stick them on a poster and write an explanation of how they know they match.

If learners have difficulty, stop the session and ask questions that may help to develop strategies. For example:

If the cumulative frequency graph is flat between scores of 40 and 60, what does that tell you about the frequency graph between these scores?

When the frequency graph is high, what does that say about the steepness of the cumulative frequency graph? Why?

Can you see a link here with speed–time graphs and distance–time graphs?

How can you get the range from a frequency graph? . . . from a cumulative frequency graph?

Reviewing and extending learning

Invite learners to come to the front and share what they have learned. Each group can be asked to present its poster and explain how they know that particular cards match.

Learners who complete this task may like to make some new cards of their own. Sheet 1 – *Make up your own examples* has been provided for this purpose.

In addition, if learners wish to explore cumulative frequency graphs further, using a computer, there are programs on the internet that allow students to manipulate a cumulative frequency graph and observe what happens to the frequency bar chart and the box and whisker plot simultaneously.

The graphs and other ideas in this session may be transferred directly to the consideration of speed–time and distance–time graphs.

This activity uses multiple representations to deepen understanding of statistical ideas. This type of activity may be used in any topic where a range of representations are used. Examples in this pack include:

N1 Ordering fractions and decimals;

N5 Understanding the laws of arithmetic;

A1 Interpreting algebraic expressions;

A6 Interpreting distance–time graphs;

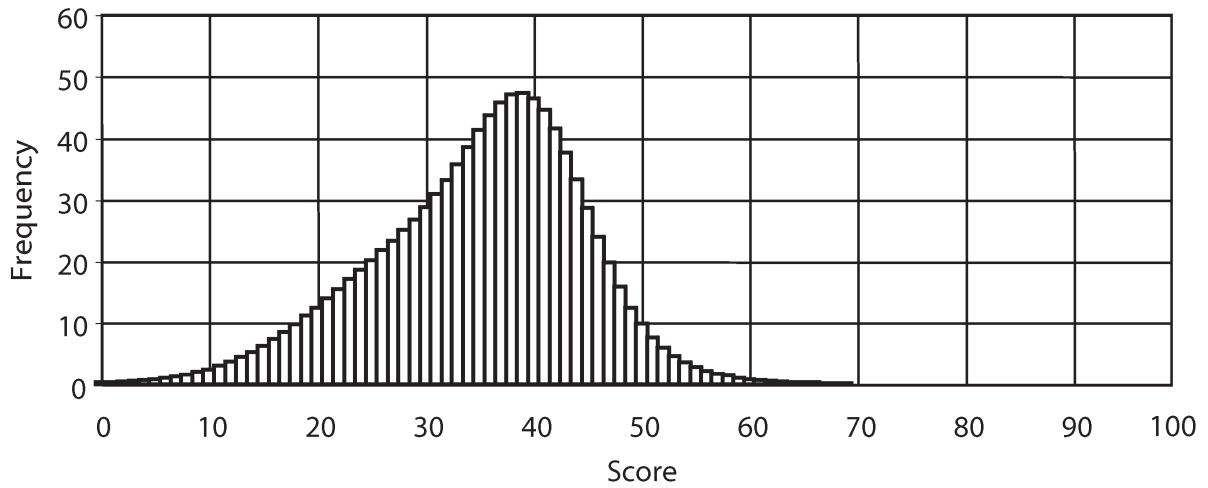
SS6 Representing 3D shapes.

What learners might do next

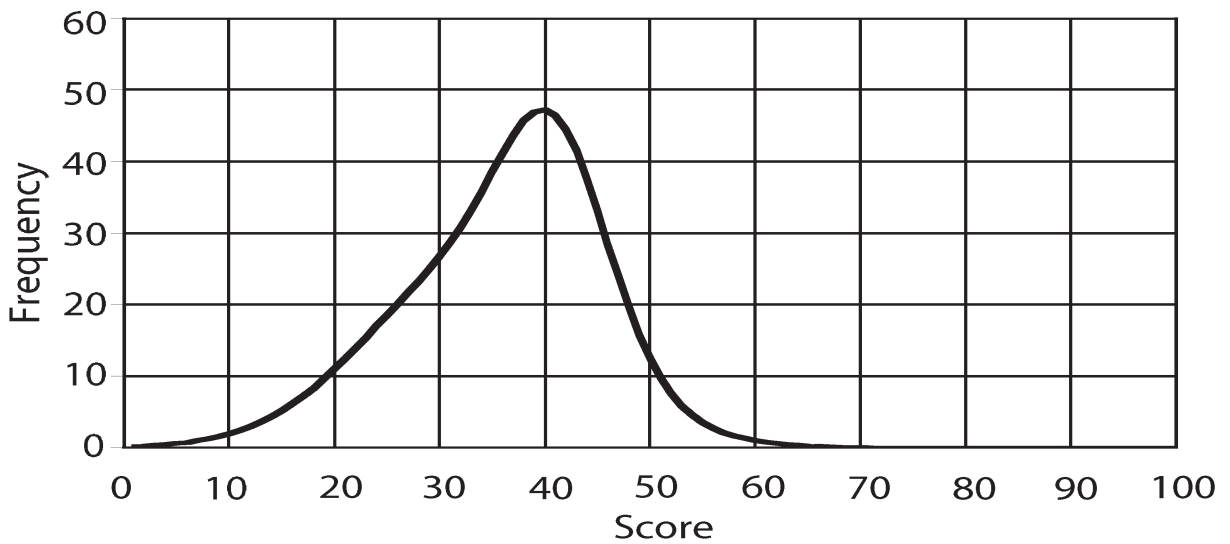
Further ideas

S6 OHT 1 – Discrete and continuous representations

Frequency bar chart



Frequency line graph



Grouped frequency table

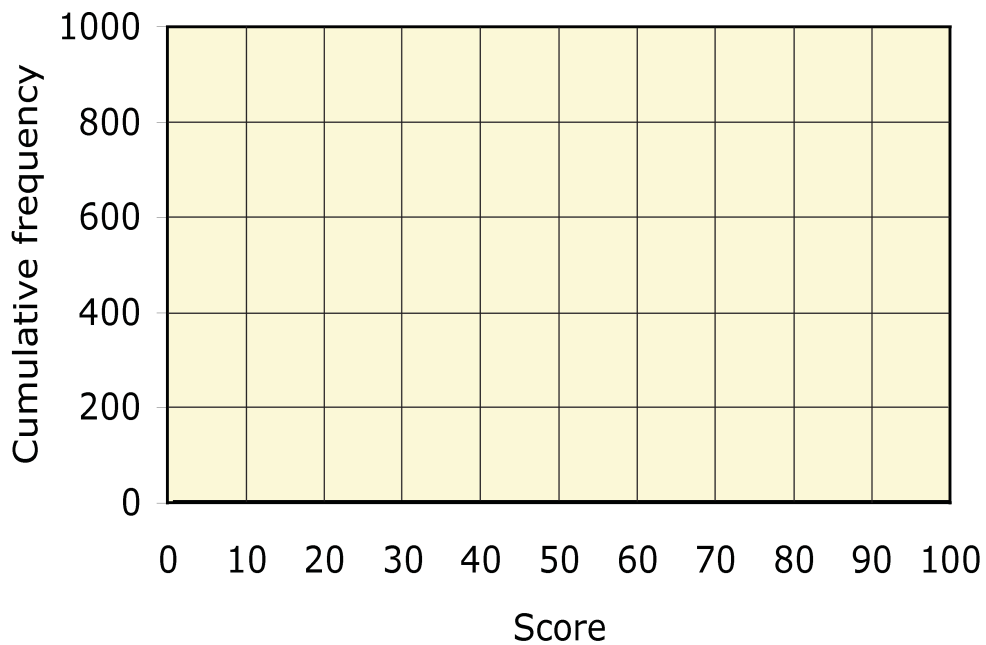
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S6 OHT 2 – Cumulative frequency, box and whisker

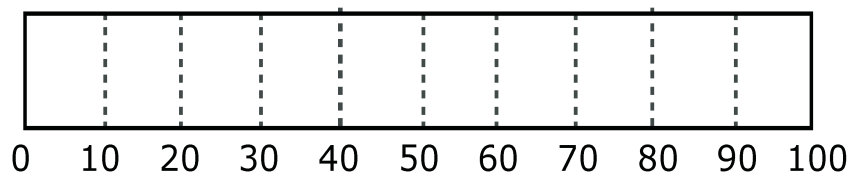
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| Cumulative frequency | | | | | | | |

Cumulative frequency graph

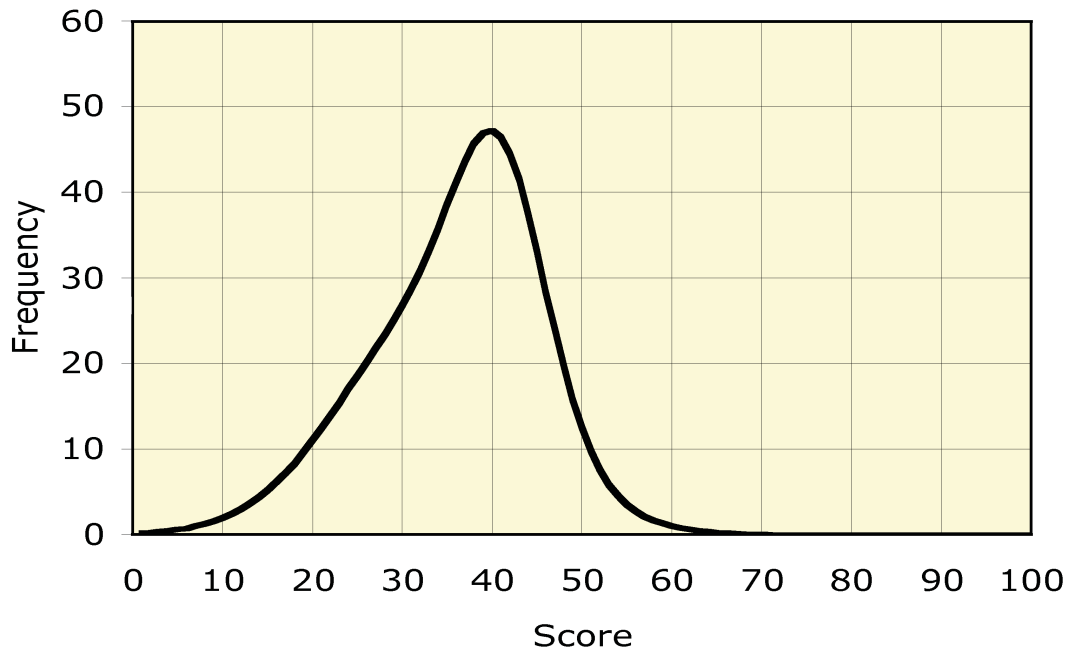


Box and whisker plot

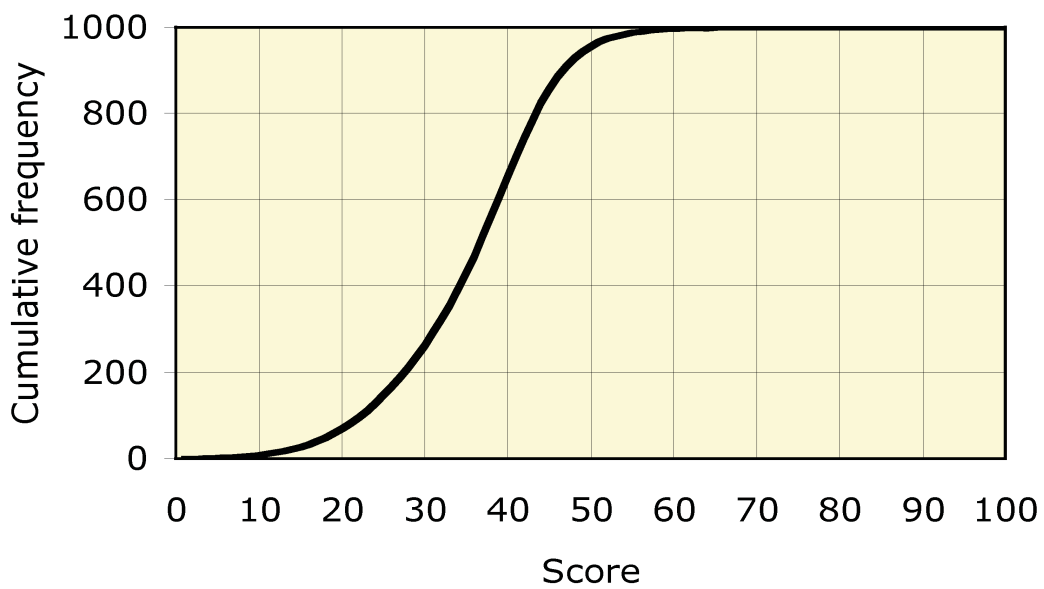


S6 OHT3 – Frequency, cumulative frequency, box and whisker

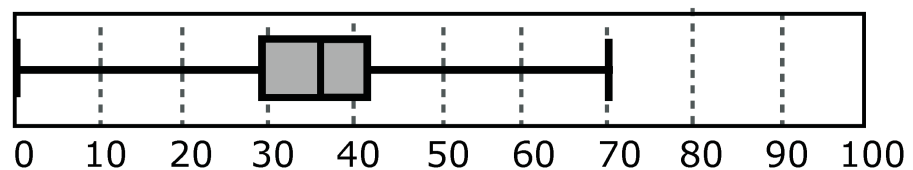
Frequency line graph



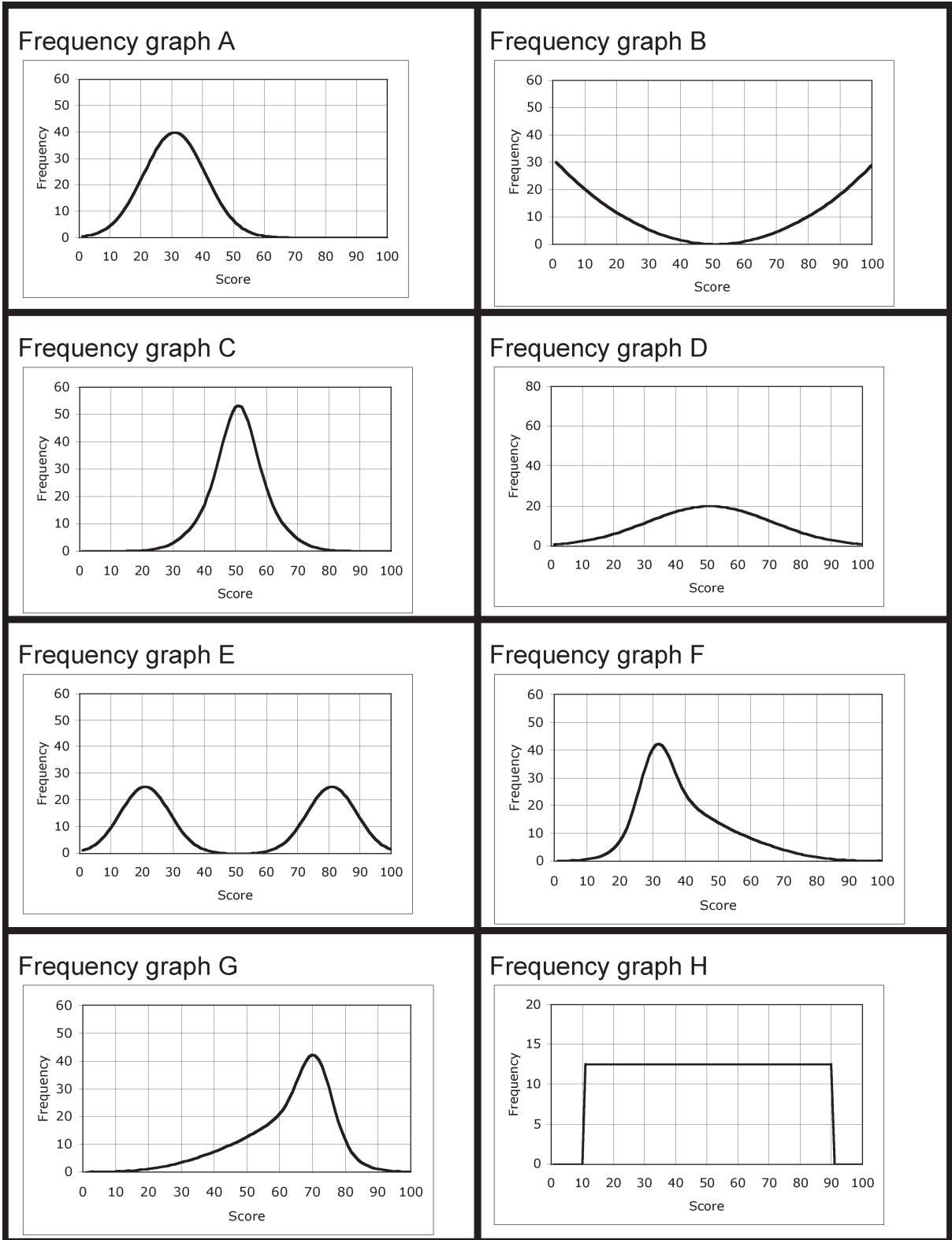
Cumulative frequency graph



Box and whisker plot



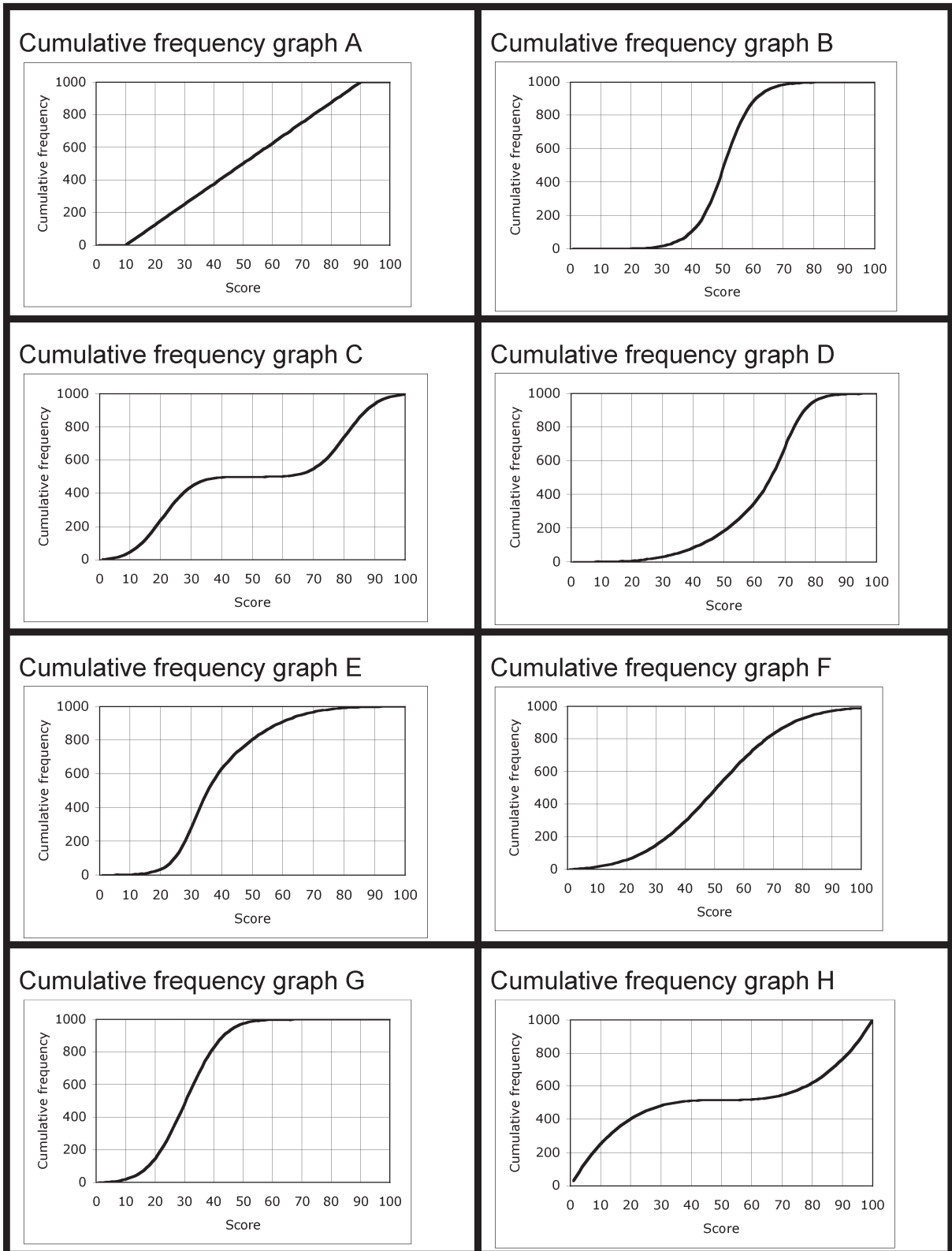
S6 Card set A – Frequency graphs



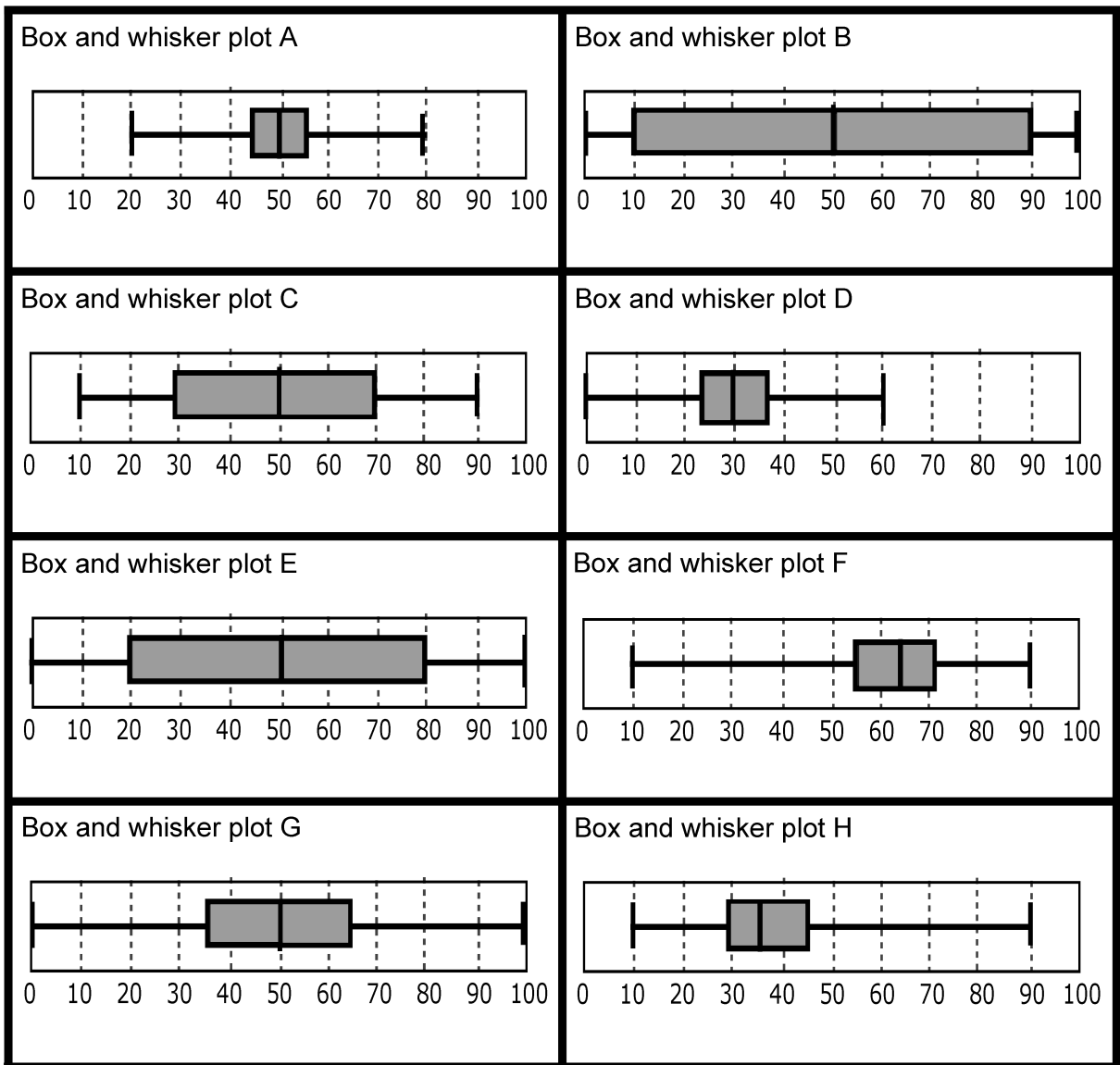
S6 Card set B – Statements

| | |
|---|--|
| <p>This was the sort of exam where you could either do everything or you couldn't get started.</p> | <p>This exam did not sort out the better-performing candidates from the poorer-performing ones. They all got similar marks.</p> |
| <p>Two groups of candidates sat the exam. One group had studied the work for two years. The other group had only just begun.</p> | <p>This exam resulted in a huge spread of marks. Everyone could do something but nobody could do it all.</p> |
| <p>In this exam, the mean mark was greater than the modal mark.</p> | <p>In this exam, the mean mark was smaller than the modal mark.</p> |
| <p>In this exam, the median and the modal marks were the same. There was a very wide range of marks.</p> | <p>This exam was much too difficult for most candidates.</p> |

S6 Card set C – Cumulative frequency graphs

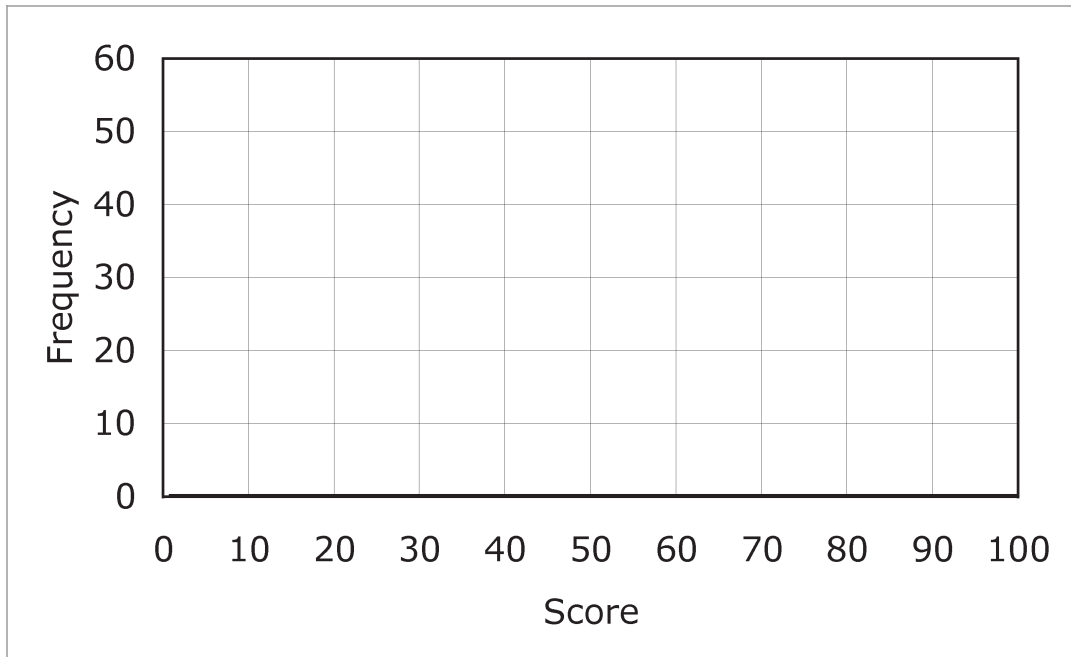


S6 Card set D – Box and whisker plots

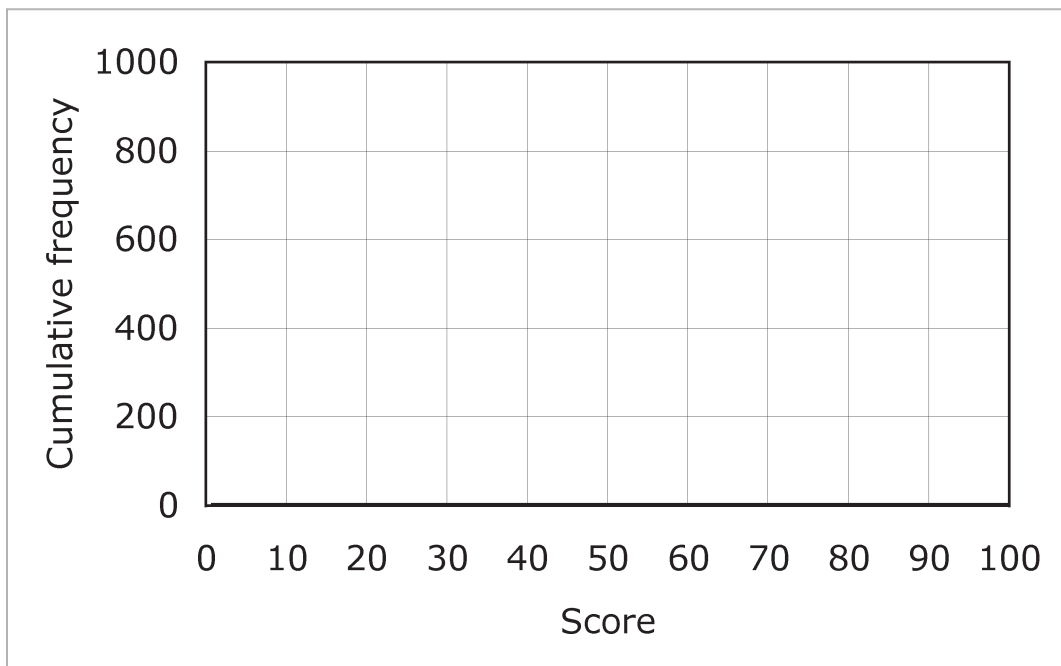


S6 Sheet 1 – Make up your own examples

Frequency graph



Cumulative frequency graph



Box and whisker plot

